T-1005 Report
(g-2 Detector Team)

April 23rd, 2012

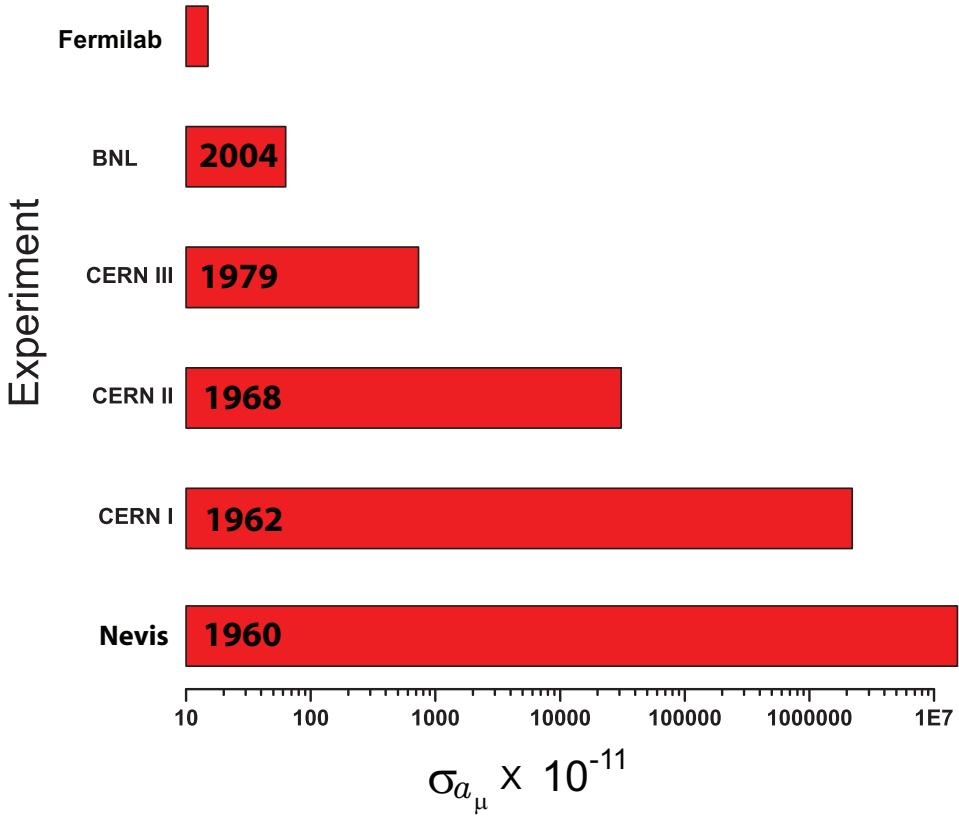
Groups Involved (on site for all or part of the run)

Washington
Kentucky
Virginia
Fermilab
Shanghai
Cornell

D. Hertzog / UW

Overview

- BNL E821 measured muon g-2 to 0.54 ppm
- Measurement was statistics limited
  - Increase statistics by moving to Fermilab
    - Goal > 21x increase
  - Reduce systematics with new detectors (among other things)
    - Goal ~ factor of 3 reduction
- Overall goal is factor of 4 improvement in measured value of muon g-2



Questions for this beam test

Calorimeter: Tungsten SciFi or PbF2?

Photodetector: Very fast PMT or SiPM?

Digitizer: 500 MHz or 1 GHz?

Equipment Deployed & Tested

- **EM Calorimeters**:
  - PbF2 array of 7 crystals in 2 x 3 x 2 stack (various wrapping, couplings)
  - PbW04 crystal (as alternative in stack above)
  - W/SciFi calorimeter
  - PbGlass (Fermilab device as reference)
- **Readout devices**
  - Very fast Hamamatsu 8-Stage, R9800 PMT
  - 16-Channel Hamamatsu SiPM 12 x 12 mm^2, 50 mm pitch, 56000 pixels, custom summed amplifier card
  - Various Photonis and EMI 22 mm PMTs for side crystals
- **Beam defining equipment & trigger counters**
  - Fast MWPC with 3% Dimethoxy Methan 15% Isobutane, rest Argon
  - 1.5 cm wide scintillator “finger counters”; larger paddle
  - Cherenkov
- **Electronics / DAQ test equipment**
  - 8-channels of 12-bit, 500 MHz digitizers
  - 2-channels of 8-bit 1 GHz digitizers
  - **MIDAS** full system in test mode related to g-2 designed architecture

g-2 Program Goals and Highlights

- Short pulses
- Segmentation: 24 arrays of 5x7 channels
- Good resolution
- Dense (short radiation length)

1

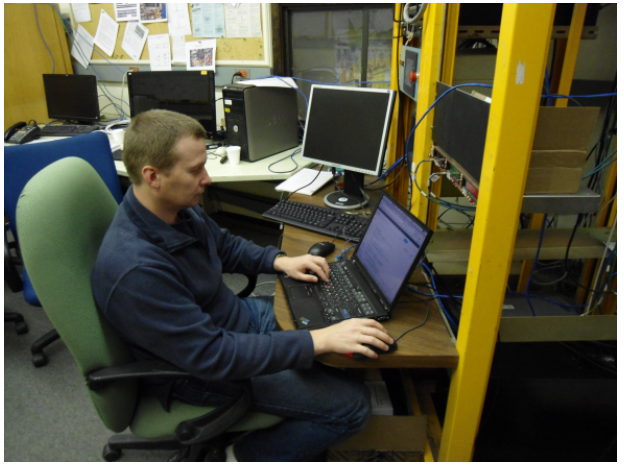
PbF2 Cherenkov; Typically 3-4%/sqrt(E);
Pulse-optimized **SiPM array**, can be used in storage ring magnetic field
Fast PMTs as backup; requires complex lightguides

2

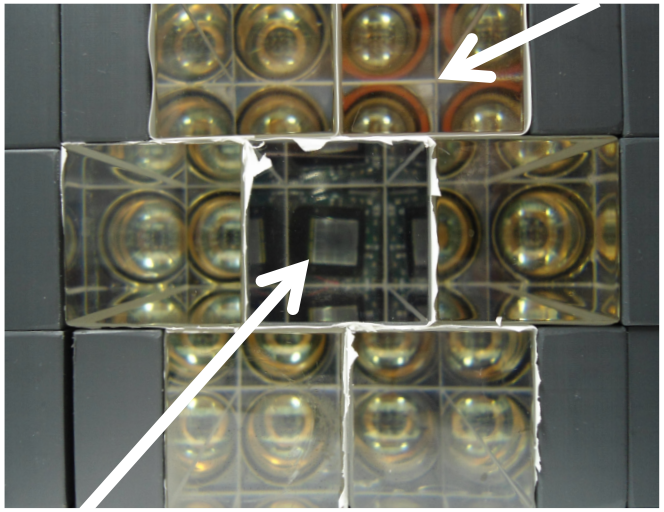
W/SciFi ; Typically 12-15%/sqrt(E). Very dense; slightly cheaper.
Similar readout options

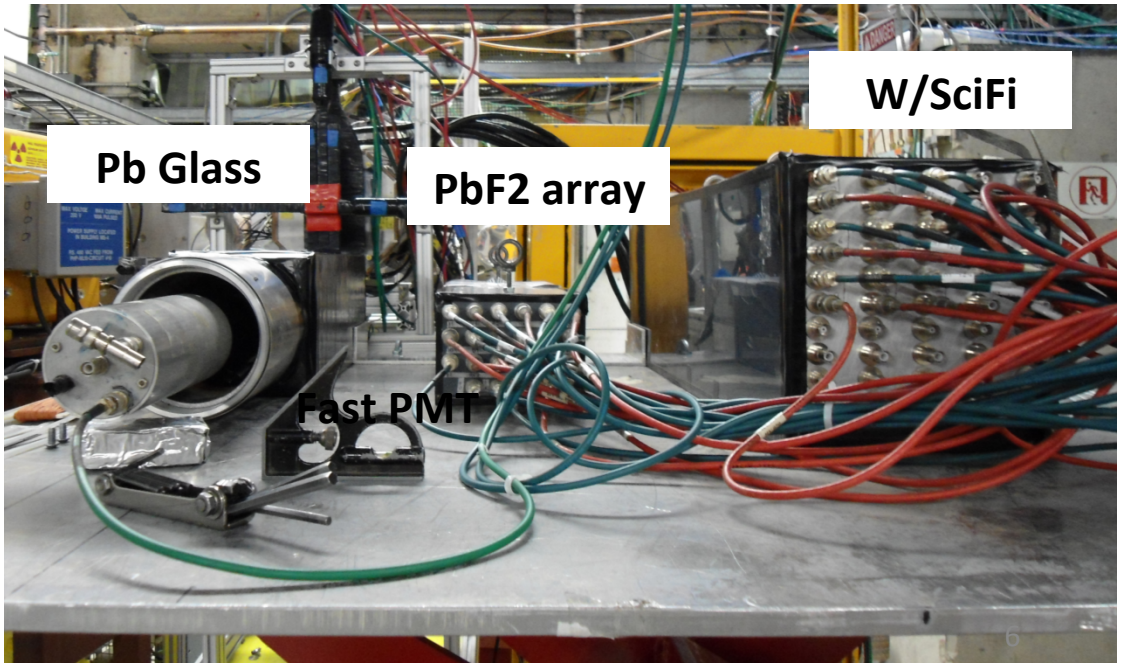
Setup

Crystal preparation



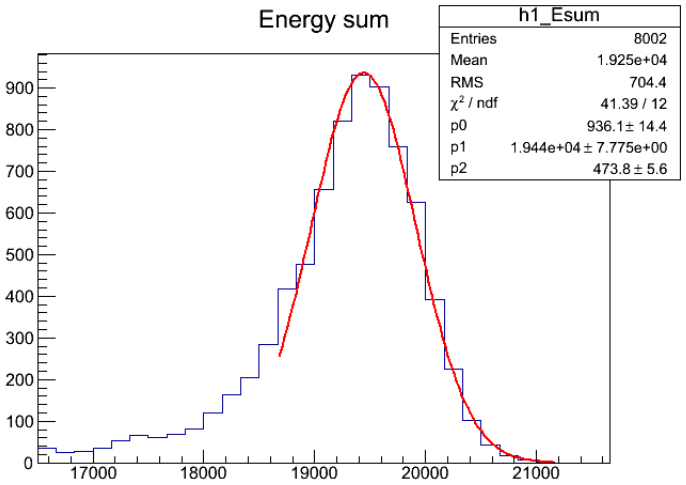
MIDAS DAQ



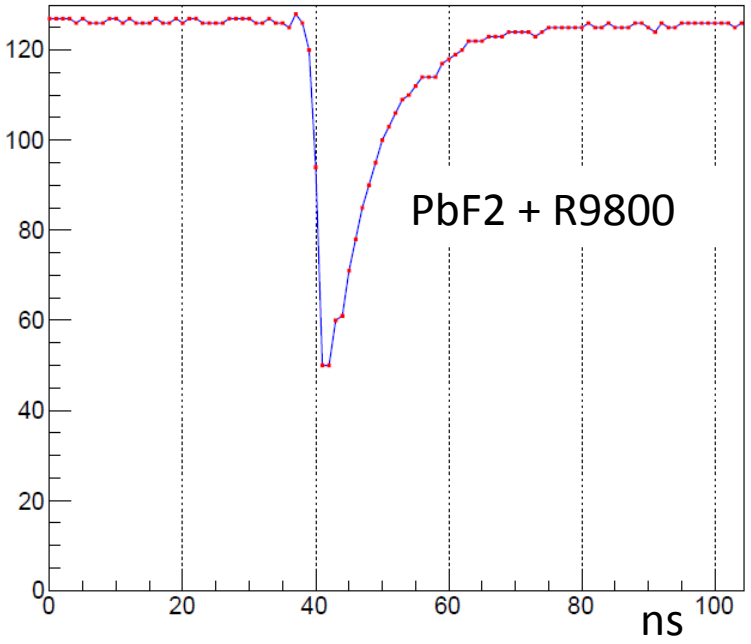


Preliminary Findings – PbF2

- Wrapping: Millipore paper; Black end; Optical grease
  - Variants: all white → longer pulse; all black → short pulse but low light; silicon interface → much lower light
- Pulse shape
  - FWHM ~8 ns; FWTM ~20 ns
- Resolution @ 4 GeV
  - 2.4% (includes ΔP/P of beam)



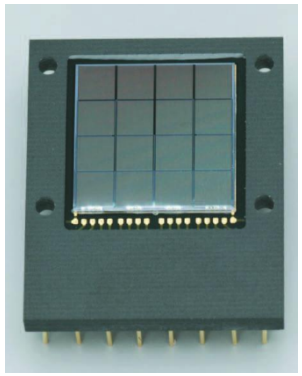
PbF2 Sum of 7 Crystals



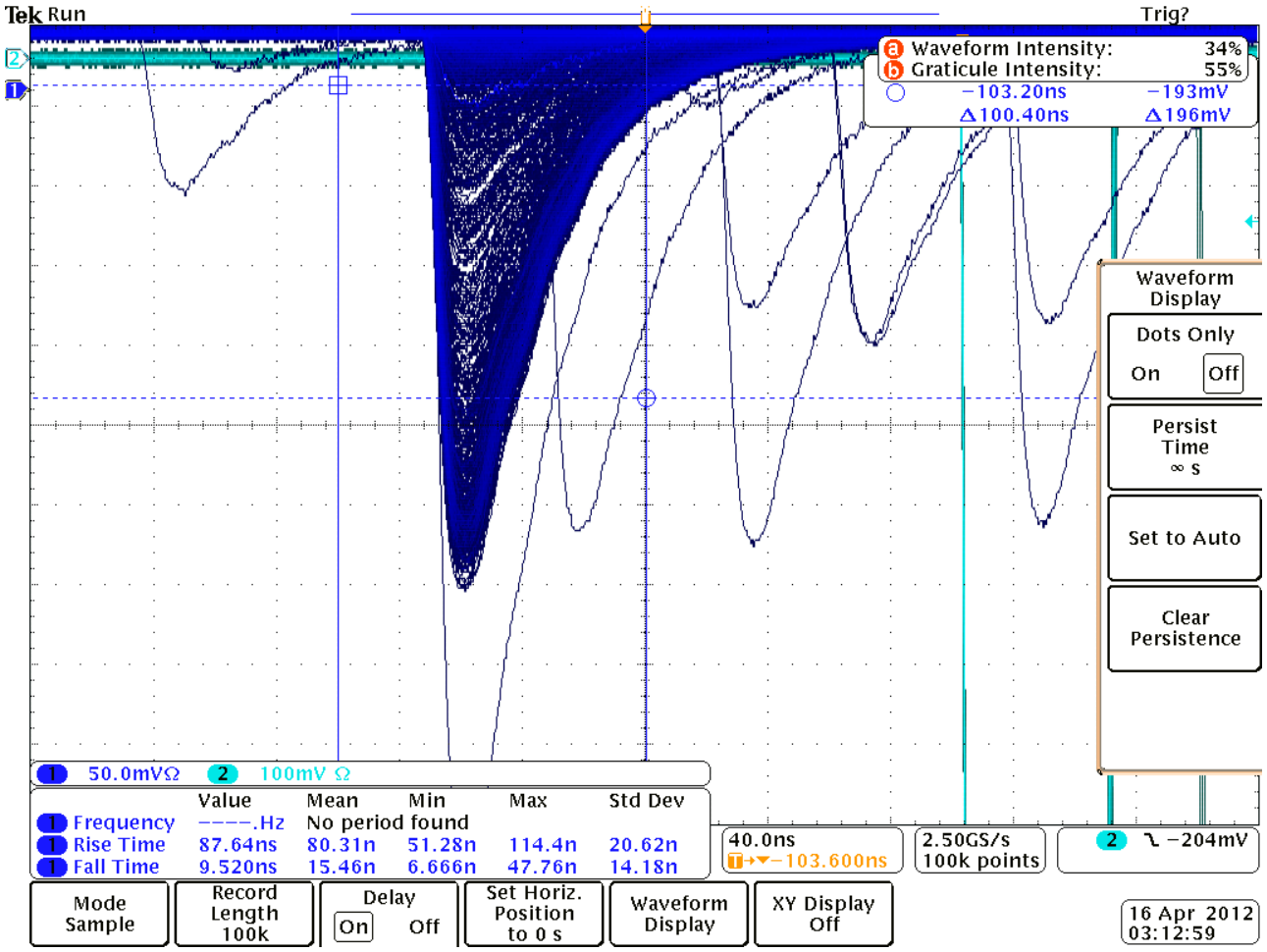
Typical Program

- Calibrate all tubes at 4 GeV
- Sweep energies with open trigger
  - 1, 2, 3, 4, 5, 8 GeV
- Vary wrapping, couplings, detectors, readout devices, angles of impact, rate of beam
- Record pulse shapes, scope shots, long acquisition periods of digitized islands for pulse finding and energy reconstruction

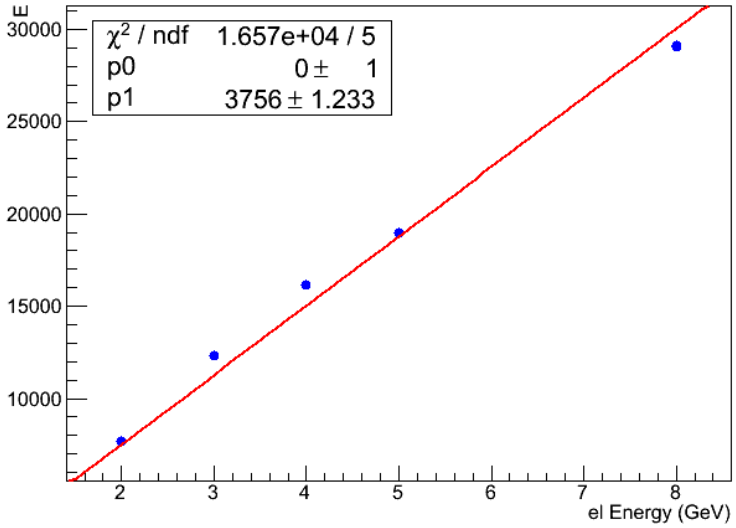
16-channel SiPM – first tests
Analysis of array in progress

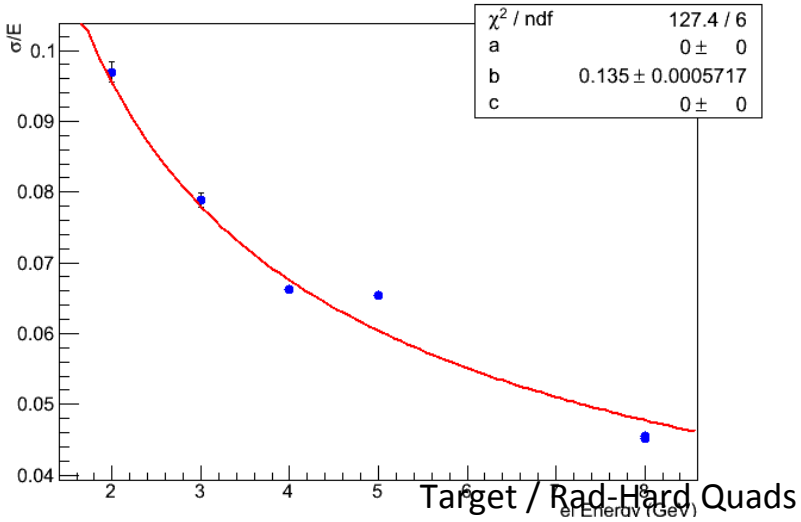


12 x 12 mm^2

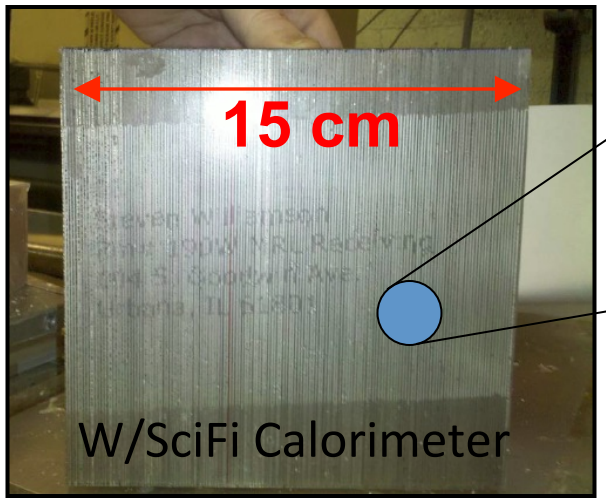


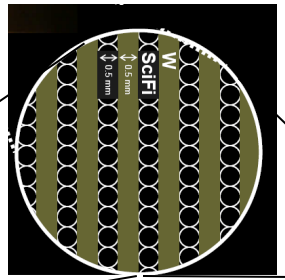
W/SciFi – followup to our 2010 run (simple analysis)

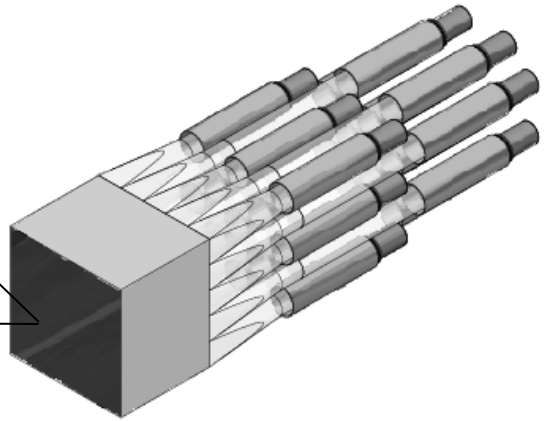




Target / Rad-Hard Quads







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The end …

Thanks Fermilab for fantastic **SUPPORT** and excellent **BEAM** !!!

The g-2 Detector Team